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ORIGINAL ARTICLE

The anisotropic distribution of the dark energy within the scope of LRS Bianchi type I model

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Abstract We investigate the anisotropic locally rotationally symmetric (LRS) Bianchi type I cosmological model with dark matter and anisotropic dark energy. We assume that the shear scalar (σ) is proportional to expansion scalar (θ). A special law is introduced for two skewness parameters that describe the deviation of pressure from isotropy. This law can lead to models: the hybrid expansion, the big rip and the little rip. The behavior of the Universe is discussed depending on the numerical parameters of the models.

Keywords Bianchi type I model · Dark energy · Anisotropic dark energy

1 Introduction

There are anomalies in the observed cosmic microwave background (CMB) at the largest scales (Smoot et al. 1992; Bennett et al. 1996; Hinshaw et al. 2003 2007, 2009; Nolta et al. 2009). The observed quadrupole amplitude has a lower value than the quadrupole expected from a Λ-dominated cold dark matter (ΛCDM) standard model. The features in the CMB temperature anisotropies have led to the need to revise the version of the Friedmann–Lemaitre models. It is known that Bianchi Universe can generate anisotropy of CMB (Ellis 2006). In addition to the nontrivial spatial geometry of the Universe, other causes of these anomalies were proposed and discussed: a systematic error, a pure statistical fluke, astrophysical (Eriksen et al. 2004; Copi et al. 2006).

An important role in the dynamics of the Universe is played by dark energy (DE). Using observational data, Melchiorri et al. (2003) demonstrated the bound on the equation of state ω_{de} to be $-1.38 < \omega_{de} < -0.82$ at $95^{\circ/\circ}$ confidence level. The negative pressure of DE provides acceleration of the Universe. The anomalies of the CMB enter inside the horizon at the same epoch that the DE dominance begins. It is logical to assume that the CMB features are consequences of the anisotropic nature of DE. The authors Rodrigues (2008), Koivisto et al. (2008), Koivisto and Mota (2008) proposed the mechanism of DE with anisotropic equation of state (EoS) parameter. The EoS parameter of DE may be determined separately on each spatial axi. In this case, the expansion rate of the Universe becomes direction dependent at late times. This idea was developed by other researchers. For example, in the papers (Akarsu and Kilinc 2010; Yadav 2011; Yadav and Yadav 2011; Yadav et al. 2011; Saha and Yadav 2012), anisotropic DE models were studied in the framework of Bianchi models with constant deceleration parameter.

We investigate the anisotropic locally rotationally symmetric (LRS) Bianchi type I cosmological model with dark matter (DM) and anisotropic DE. Similar to the article (Saha and Yadav 2012), we assume that the shear scalar (σ) is proportional to expansion scalar (θ). In contrast to the article (Akarsu and Kilinc 2010; Saha and Yadav 2012) an another law is assumed for the deviation from isotropic EoS of DE. This assumption allows us to obtain a more realistic model of the expansion history of Universe referred to as the hy-

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